Disease Resistance in Blueberry-Steps toward an Integrated Utilization Approach

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Abstract

The USDA-ARS and Rutgers University (at Chatsworth, New Jersey) collectively house a significant collection of blueberry cultivated and wild germplasm. This collection of germplasm has been used to evaluate genotypes for resistance to *Monilinia vaccini-corymbosii* (mummy berry), *Colletotrichum acutatum* (anthracnose), *Botryosphaeria dothidea* (stem blight), *Phomopsis vaccinii* (twig blight), and blueberry scorch virus. These data have been compiled with similar information from other sources to produce a database that can be used for IPM recommendations, cultivar planting recommendations, and for breeding programs. Principal component analysis (PCA) can be used to compare cultivars across multiple diseases to optimize selection options.

INTRODUCTION

The USDA-ARS at Chatsworth, New Jersey houses the world's largest collection of blueberry cultivars, as potted material and as in-ground plants. These plants have been subjects of numerous studies of disease resistance, plant pathology, morphology, phenology, and fruit quality. A major aspect of the program has been screening cultivars for disease resistance with the aim of identifying sources of resistance in a cultivated background that could be used in breeding. The Marucci Center also houses an extensive collection of *Vaccinium* species germplasm, and parts of this collection have also been evaluated in our program.

MATERIALS AND METHODS

Disease resistance screening has been performed generally in one of two ways: either on potted plants with highly supplemented inoculum levels and enhanced environmental conditions or on potted plants using direct graft or wound inoculation. Typically, accessions are tested for a minimum of 2-3 years alongside 'standard' cultivars. Specifics regarding methodology can be found in the cited references of Table 1. The goal of our disease resistance screening in all cases has been to determine the strongest sources of resistance. Thus, it should be recognized that cultivars we identify as mid-range for susceptibility may in fact perform quite well under typical field conditions where inoculum pressure would presumably be lower. A general extrapolation to predict possible field performance of uncommon cultivars could be achieved by comparing their rank versus commonly grown cultivars whose performance under field conditions is well-established.

RESULTS AND DISCUSSION

A brief summary of some of our findings is as follows:

Monilinia vaccinii-corymbosi (mummy berry shoot blight)

Excellent sources of resistance are available in highbush blueberry. Among the more resistant highbush cultivars are Jersey, Duke, Bluejay, and Elliott (Stretch et al., 1995). Among highbush cultivars field resistance appears to result from avoidance and

true resistance (Ehlenfeldt et al., 1996, 1997). Among rabbiteye cultivars, the resistance is much weaker. The better rabbiteye cultivars are Coastal, Delite, Centurion, and Walker, all of which had more than 50% shoot blighting in our tests (Ehlenfeldt and Stretch, 2000). The lowbush cultivars Fundy and Augusta had particularly good resistance (unpublished results). Among *Vaccinium* species, *V. boreale* and *V. myrtilloides* had particularly good resistance (Ehlenfeldt and Stretch, 2001).

***Monilinia vaccinii-corymbosi* (mummy berry fruit infection)**

Highbush cultivars showed a wide range of resistance, but several more resistant cultivars were Reka, Bluejay and Brigitta Blue. Half-high cultivars also appeared to have superior levels of resistance, and this is apparently due to the higher levels of lowbush germplasm found in half-highs. No correlation was found between susceptibility to shoot blight and susceptibility to fruit infection, with r = -0.25 (Stretch and Ehlenfeldt, 2000). Among *Vaccinium* species, *V. boreale*, *V. myrtilloides*, *V. pallidum*, *V. tenellum*, and *V. darrowii* all had excellent levels of resistance to fruit infection (Stretch et al., 2001).

***Colletotrichum acutatum* (anthracnose fruit infection)**

Considerable variation exists for resistance, with little indication of any cultivar possessing very high levels of resistance as seen for mummy berry. Among a variety of cultivars tested, Little Giant, Legacy, Elliott, and Brigitta Blue all had less than 20% infected fruit. No particular cultivar type (lowbush, half-highs, southern highbush, highbush, or rabbiteye) appeared to have greater resistance than the others (Polashock et al., 2005).

***Colletotrichum acutatum* (anthracnose foliar infection)**

Tested with an in vitro leaf disk assay, the cultivars found to have particularly good levels of resistance were Burlington, Sharpblue, Reka, and Berkeley. Cultivars with better levels of resistance to fruit and foliar infection included Sharpblue, Legacy, Little Giant, Elliott, and Blue Ridge. Foliar infection was not correlated with fruit infection (r = 0.15) (Ehlenfeldt et al., 2005).

***Botryosphaeria* stem blight**

Resistance to Botryosphaeria stem blight was assessed by the length stem lesions after artificial inoculation. For this disease, half-high and lowbush cultivars stood out as being more resistant, in general, than other types of blueberries. Among highbush cultivars, Weymouth was the most resistant. 'Ozarkblue', 'Bluecrop', 'Duke', and 'Blueray' were some of the most susceptible to this pathogen (Polashock and Kramer, 2006).

***Phomopsis* twig blight**

Resistance to Phomopsis twig blight was also assessed by length of twig lesions after artificial inoculation, and the results were similar to those for *B. dothidea* in that half-high and lowbush cultivars, in general, tended to be more resistant than other types of blueberries. Cultivars such as Emerald, Powderblue, Legacy, Hannah's Choice and Duke were some of the most susceptible to *P. vaccinii* (Polashock and Kramer, 2006).

Blueberry Scorch virus

Studies are ongoing, so it is premature to derive any conclusions, but thus far, we have failed to achieve infection by direct grafting in 18 of 96 cultivars. These cultivars are being further evaluated and scrutinized for possible resistance.

Red Ringspot virus

This study involved evaluation of infection incidence in a selection field with high natural infection pressure and small families with many parents in common across families. *Vaccinium lamarckii* Camp (4x, lowbush type, syn. *V. angustifolium* Ait.), *V.*

amoenum Ait. (6x, rabbiteye type; syn. *V. virgatum* Ait.), 'Woodard' (6x), and 'Earliblue' (4x) were judged to be likely to have higher levels of alleles for BRRV resistance based upon infection frequency in progeny families (Ehlenfeldt et al., 1993).

Other literature sources exist that document relative responses to diseases as well as insect feeding (Baker et al., 1995; Compendium of Blueberry and Cranberry Diseases, 1995; Creswell and Milholland, 1987; Milholland, 1982; Nelson and Bittenbender, 1971; Pepin and Toms, 1969; Rooks et al., 1995; Smith, 2004; Smith et al., 1996).

CONCLUSIONS

The results of multiple resistance screening trials are most useful if put in a user-friendly format. To this end, in 2001 we incorporated the data available into a spreadsheet-based database that would allow the evaluation of resistances from various sources, our own and others. Our dataset is now much richer than in 2001 and we are currently in the process of producing an updated resistance database along with additional information on cultivar phenology, fruit quality, cold hardiness, antioxidants, and other characteristics. Additionally, we have appended to the working version of our database, supporting files that may assist in selecting cultivars for research, breeding, or production. With this information it is possible to use principal component analysis or weighting factors to aid in the selection of breeding parents or to simply assist in selecting cultivars for commercial plantings.

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Tables

Table 1. Blueberry germplasm screened by the USDA-ARS at Chatsworth, New Jersey.

Pathogen	Disease name	Methodology	Material screened	Accessions screened	Reference
Monilinia vaccinii-corymbosi	mummy berry shoot blight	potted plant material, open-air nursery, supplemented inoculum	highbush cultivars (mixed cultivars)	55 (140+) [1]	Stretch et al.,1995
"	"	"	rabbiteye cultivars	26	Ehlenfeldt and Stretch, 2000
"	"	potted plant material, greenhouse, supplemented inoculum	*Vaccinium* species	31 10 species	Ehlenfeldt and Stretch, 2001
"	mummy berry fruit infection	potted plant material, open-air nursery, supplemented inoculum, bee-transferred conidia	highbush cultivars (mixed cultivars)	68 (140+) [1]	Stretch and Ehlenfeldt, 2000
"	"	potted plant material, greenhouse, hand-pollinated and inoculated	*Vaccinium* species	140 7 species	Stretch et al., 2001
Colletotrichum acutatum	anthracnose fruit rot	potted plant material, nursery & greenhouse, supplemented inoculum	cultivars – all types	100	Polashock, et al., 2005
"	anthracnose foliar infection	leaf disks, applied inoculum	cultivars – all types	149	Ehlenfeldt et al., 2005
Botryosphaeria dothidea	Botryosphaeria stem blight	potted plant material, greenhouse, wound inoculated	cultivars – all types	50	Polashock and Kramer, 2006
Phomopsis vaccinii	Phomopsis twig blight	potted plant material, greenhouse, wound inoculated	cultivars – all types	50	Polashock and Kramer, 2006
Blueberry Red Ringspot virus (BRRV)	Red Ringspot virus	selection field, natural infection	mixed germplasm	1031	Ehlenfeldt et al., 1993
Blueberry Scorch virus (BBScV)	Blueberry Scorch virus	grafts on potted plant material	highbush cultivars	96	-

[1] First value indicates accessions described in published reference. Bracketed values indicate number of accessions screened to date.